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OF THE BUREAU OF STANDARDS

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INTERDEPARTMENTAL CONFERENCE ON CHEMICAL LIME

Because of its cheapness, lime is being used more and more as the basic raw material in a number of chemical industries. It is being utilized in many different manners, and economy demands that in so far as possible the lime used shall have the properties desired for the particular purpose. The user wishes to know what kinds of lime are available and the producer the quality of lime demanded in the various industries. This information can be made available by the preparation of specifications, and this is the purpose of the Interdepartmental Conference on Chemical Lime. This conference is composed of representatives of the Geological Survey, of the Interior Department; Bureau of Soils, Bureau of Chemistry, and Fixed Nitrogen Laboratory of the Department of Agriculture, the Chemical Warfare Service, of the War Department; and the Bureau of Mines and Bureau of Standards, of the Department of Commerce. To date recommended specifications for the following purposes have been issued as circulars of the Bureau of Standards and may be obtained from the Superintendent of Documents at 5 cents per copy. Quicklime and Hydrated Lime for Use in the Cooking of Rags for the Manufacture of Paper; Limestone, Quicklime, and Hydrated Lime for Use in the Manufacture of Glass; Quicklime

for Use in Causticizing; Limestone and Quicklime for Use in the Manufacture of Sulphite Pulp; Quicklime and Hydrated Lime for Use in the Manufacture of Sand-Lime Brick; Quicklime and Hydrated Lime for Use in the Manufacture of Silica Brick; Ceramic Whiting; Quicklime and Hydrated Lime for Use in the Absorption of Carbon Dioxide; Quicklime and Hydrated Lime for Use in the Purification of Water; Limestone, Quicklime, and Hydrated Lime for Use in the Manufacture of Sugar; Quicklime and Hydrated Lime for Use in the Manufacture of Calcium Arsenate. Several other specifications are in preparation, including lime for use in the manufacture of leather and lime for use in the manufacture of soap. After a specification has been prepared by the conference and before publication criticism is always solicited from both the producer and user of the lime in question.

EFFECT OF FINE GRINDING OF PORTLAND CEMENT ON THE STRENGTH OF CONCRETE

About 10 years ago the bureau began an investigation to determine the effect of fine grinding of cement on the strength of concrete. Since the beginning of the work other investigators have shown this effect for short periods of time, usually one year. It is felt that the bureau's tests are of particular interest, as they extend over a 10-year

period, and show the effect of fine grinding on the strength of concrete at definite intervals of time during this period.

For the investigation five commercial brands of cement, as received direct from the manufacturers and representative of their marketable product, were used. Each cement as it was received was thoroughly mixed and divided into two lots. One lot was used as received for making concrete, while the other was ground in a ball mill for one and one-half hours before use.

Concrete cylinders 8 by 16 inches were made from both lots of cement, Potomac River sand and gravel being used as the aggregate. The materials were proportioned either 1:2:4 or 1:3:6 by volume. After remaining in the molds for 24 hours the specimens were stored in moist air for 28 days. After the 28 days' curing the specimens were placed out of doors exposed to Washington weather conditions until broken. Compressive tests were made at the 7-day, 28-day, 6-month, 1, 2, 3, 5, and 10 year periods. The extreme variation in fineness in the two lots of any one cement was 20.1 per cent on the standard No. 200 cement sieve.

From the results of these tests the following conclusions may be drawn: No retrogression is shown in the compressive strength of the concretes at the end of the 10-year period. In general, the fineness of the cement increased the strength of the concrete. All cements do not give the same increase in strength with the same increase in fineness. The effect of fineness of cement on the strength of concrete diminishes with age. The 1:2:4 mixes show better increases of strength with the same increase in fineness than do the 1:3:6 mixes.

SCRUBBING TESTS ON MARBLE

One of the problems in the bureau's research work on marble is to determine the ultimate effect of various commercial cleaning preparations on the polished marble surface. For this purpose a machine has been built which consists of a broad-faced wheel so constructed that

sample slabs of marble can be mounted around its circumference. This is geared down to turn once in six hours. At the lowest point of this wheel is a scrubbing drum covered with felt. This drum turns eight times per minute, and by means of a balance bearing it is weighted against the marble specimens to give the desired scrubbing pressure. The felt dips into a pan of the scrubbing preparation, which it carries up, and scrubs the marble specimens as they pass. The test is carried on continuously until the marble has received as many scrubblings as it would normally get in several years of actual service.

DURABILITY OF RUBBER CANCELING STAMPS

The bureau is many times called upon to make tests to determine the durability of articles of manufacture which require the design and construction of special testing equipment. Such was the case recently when a request was received from the Post Office Department to determine the durability of a new type of rubber canceling stamp. These stamps are used for canceling packages and letters in the smaller post offices, where it would not be economical to install canceling machines, and in the larger offices for use on packages of irregular shape.

The new type of stamp is of more flexible construction than those previously used and was designed to produce a more legible postmark with less pressure. A special machine was constructed to test out these stamps in comparison with the older type. It consisted essentially of an arm, to which the stamp was secured, so controlled by means of cams and levers that the stamp automatically struck first the ink pad and then a strip of paper. The paper was fed along slightly after each stroke of the machine, so that separate impressions were made.

The new type of stamp proved to be superior to the older type, and after 1,000,000 impressions, which required two weeks of continuous operation, the stamp still produced a legible postmark, and no weakness in its construction was

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BENDING FATIGUE OF ROPE YARN

Apparatus has been designed and built by the bureau for studying the bending fatigue of a rope yarn. Every effort was made to keep the test method as simple as possible, so that it can be reproduced easily and cheaply in the mill. The construction is such that measurements of a single characteristic are obtained. These features are desirable for the proper interpretation and correlation of test data from different sources. So much interest has been shown by various manufacturers in this work that the bureau believes this apparatus will be accepted and used in the cordage mills.

In this apparatus a rope yarn is bent over a cross arm at a certain number of oscillations per minute. To one end of the yarn a weight is attached which slides in a guide, so that the twist of the yarn is retained. An auxiliary instrument which preserves the original twist was constructed to be used in transferring the specimen from the rope or coil to the apparatus.

After a study of the variables which affect this apparatus the following test procedure is recommended: The angle of bending should be that in which the cross arm makes a 90° angle with the vertical when at the highest point of its stroke. The cross arm should be oscillated through 90° at the rate of 110 (plus or minus 5) oscillations per minute. The cross arm should be of $1/16$ inch steel wire. An auxiliary instrument which will preserve the original twist should be used in transferring the specimen from the rope or coil to the clamps of the apparatus. An average of at least 30 specimens should be used to obtain a result if an error not to exceed 5 per cent is desired.

COTTON STALKS AS PAPER-MAKING MATERIAL

The number of acres of cotton harvested in the United States in 1924 was

41,360,000. The yield of stalks is estimated at 1,000 pounds per acre. At present this enormous supply of raw material is largely a waste product. The question of utilizing it in the production of paper has previously been considered by the bureau and by other investigators, but practically all tests have indicated that it is unsuitable for such use. Owing to numerous inquiries received, however, additional tests on its paper-making properties have been made.

The cotton stalks used in this investigation were shredded before shipment in a patent harvesting and shredding machine. Pulping and paper-making tests were made on both laboratory and semicommercial scale. Preliminary bleaching tests demonstrated the unfitness of the material for bleached papers because of the excessive amount of bleach required and the character of the paper produced. The stalks contain material that fails to bleach and which shows in the finished paper as small brown specks. The subsequent investigation was, therefore, confined to the production of unbleached papers.

The material was found to require severe chemical treatment and relatively long cooking for reduction to pulp. The yield of fiber was fairly good, being 35 to 40 per cent of the weight of the shredded stalks, but the paper produced was deficient in strength and of poor appearance, being suitable only for low-grade wrapping or board.

Straws of cereal plants yield as much fiber as cotton stalks, and the paper produced has better strength. The available quantity of these straws is estimated to exceed that of cotton stalks. Some mills are at present using these materials in the production of paper board. Moreover, these straws are already being collected for other purposes, while the collecting of cotton stalks means an additional operation, which increases their cost as a paper-making material.

On the basis of cost of collection, quality of paper produced, and yield of fiber obtained, the results reported herein

indicate that making paper from cotton stalks by the usual paper-making methods is not commercially feasible.

APPLICATION OF CHROMIUM TO PRINTING PLATES

A few years ago the bureau cooperated with the United States Bureau of Engraving and Printing in the development of an electrolytic process for the reproduction of engraved or intaglio printing plates, such as are used in printing securities. This process, which is still in use, produces plates having a nickel printing surface which is not as hard as the casehardened steel, of which now part and formerly all of the plates were made.

In order to increase the hardness of the nickel surface the application of chromium plating was suggested. Scratch hardness tests made at the Bureau of Standards have shown that electro-deposited chromium is harder than any steel.

During the past several months a process of chromium plating developed by H. E. Haring, of this bureau, has been successfully applied to the nickel-faced plates and to unhardened steel plates at the Bureau of Engraving and Printing. In this process a deposit of chromium about 0.0002 inch (0.005 mm.) is applied to the face of the plate. Over 1,000 plates have been thus treated, and as none of them has yet worn through on the presses it is not now possible to estimate their average useful life. The indications are, however, that the chromium-coated plates will yield several times as many impressions as the nickel plates and at least twice as many as the casehardened steel. The impressions are even better than from the originals and are very uniform, which adds to the security of the currency. It is estimated that ultimately his application of chromium will represent an annual saving to the Government of hundreds of thousands of dollars.

The bureau plans to continue this study of chromium deposition in order

to determine the fundamental principles and their relation to possible industrial applications of chromium plating.

CAST IRON FOR ENAMELING PURPOSES

The last report on this problem was published as Item 11 in Technical News Bulletin No. 95, March, 1925, and included the results obtained on a number of sample plates cast from northern pig irons claimed to blister on enameling. These castings were distributed to cooperating enamelers and also enameled in the bureau's laboratory. Both lots of sample plates were found to blister if enameled above a fairly definite temperature; that is, about 1,290° F.

The three most probable causes of the blisters are as follows: A certain amount of gas is taken up in the blast furnace, due to some difference in operating conditions in northern furnaces. It has been assumed that on remelting once in the cupola the gas is not removed, but it is on repeated meltings. Just why this should happen is not clear, because analyses of cast irons for oxygen, hydrogen, and nitrogen show no difference between ordinary and remelted irons.

The second possibility is that some element not shown by ordinary analysis is present in the pig and is responsible for the trouble. Spectroscopic analyses fail to show any difference that can be considered significant.

The third possibility is that graphite may be present on the surface, and is not wholly removed by sand-blasting. At a sufficiently high enameling temperature this graphite would react with the oxides of the enamel to form carbon monoxide, which causes blisters. By remelting something might happen to change the distribution of graphite, so that finally the surface after sand-blasting would be free from graphite.

In view of the possibilities sample plates were prepared from two northern irons melted once in the electric furnace. The scrap produced was also remelted and cast into sample plates. One north-

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ern iron has been remelted in the cupola two times and sample plates cast. The test pieces made by the above methods have been enameled at the bureau with promising results. It was found that all plates cast from the first melting in the electric furnace blistered, but not as badly when enameled by the dry process as when enameled by the wet process. Sample plates obtained by remelting the scrap, both in the electric furnace and cupola, show no blisters when enameled by the dry process and a decided reduction in blistering in the wet process. It appears that remelting the iron several times is quite beneficial in reducing the blistering of the enamel. Chemical analyses of the cupola and electric furnace melts have been made and microscopic examination is in progress.

Some of this work is an extension of the original tentative program. Unless other methods of attack appear more promising, the bulk of the original program will be followed, but will be modified as the results of the tests may indicate.

INITIAL TEMPERATURE AND MASS EFFECTS IN QUENCHING STEEL SHAPES

The bureau has been studying the rates of cooling at the centers of various sized spheres, rounds, and plates of steel immersed in different media, such as air, oil, water, and 5 per cent sodium hydroxide. The effect of the quenching temperature upon these cooling velocities has also been investigated.

A definite relationship has been found between the surface per unit of volume (or weight) of any of these shapes and the cooling velocity obtained at their centers when they are cooled in the different media. These relationships can be expressed by simple mathematical equations and are of a hyperbolic form which is close to a straight line for air and becomes more curved as the cooling becomes more drastic.

When the three shapes mentioned have the same surface per unit of volume they will have the same center cooling velocity when they are quenched in the same coolant from the same temperature.

Charts have been worked out, so that if the rate of cooling at the center of any of these simple shapes is known when quenched from any temperature in nearly any of the common coolants the rate of cooling can be computed for any shape from very small to moderately large dimensions when it is quenched from any temperature between 720 and 1,050° C. (1,330 to 1,920° F.) in the same medium.

If the cooling velocity which will completely harden any of the carbon steels is known, this information will give the maximum size of any of the simple shapes which will completely harden to the center in nearly any of the common cooling media.

PISTON-RING FRICTION

Measurements are being made at the bureau of the friction of various designs of pistons. This work was authorized by the National Advisory Committee for Aeronautics, not with the idea of developing an ideal design but rather to obtain information as to the influence which various features of design have upon the friction. Such information will be of value in predicting the performance of aircraft engines, particularly at altitude.

In these experiments the friction has been determined by measuring the power required to drive the engine with ignition and fuel shut off. Certain of these experiments have been made with the cylinder head removed, so that there would be no measurable amount of power consumed in drawing a charge into the cylinder and compressing and exhausting it.

If measurements are made first with all the rings removed from the piston, and then with all the rings in place, but otherwise under exactly the same conditions, it would appear that the difference between these two readings would be a fair measure of the friction of the rings. While there is no reason to believe that such is not the case, the tests brought out the interesting fact that the friction of a piston ring as determined in this fashion is affected by the design of the

piston with which the ring is used. For example, with the four-cylinder engine employed in these tests, the addition of the full set of three rings to each piston increased the total friction approximately 5 horsepower under certain test conditions. Under the same conditions the addition of the same piston rings to another design of piston increased the total friction less than 2 horsepower. It seems probable that the difference just mentioned is due to a difference in the extent to which the lubricant is distributed to the working surfaces. Whatever may be the explanation, it obviously is unsafe to assume that the friction of a piston ring will be the same on two pistons of different designs.

NEW SENSITOMETER

A new sensitometer of improved design for measuring the light sensitive characteristics of photographic plates has recently been completed by Raymond Davis, of the photographic technology section of the bureau.

In this sensitometer a sector wheel is rotated in front of the plates to be tested, and light of a specified color and intensity falls on the plate through measured apertures in the wheel. The exposures are nonintermittent; that is, they take place during a single revolution, and are, of course, determined by the angular openings of the sector wheel, its speed, and the intensity of the light.

A special arrangement of change gears for varying the speed of the sector wheel is provided, so that it is possible to cover a speed range from 480 r. p. m. down to 0.0586 r. p. m. in steps varying by powers of two.

The usual (Hurter & Driffeld) type of sector wheel can not be used with a non-intermittent machine, because the largest aperture is in two 90° parts. In the present design this difficulty is overcome by centering all apertures on the same radial line, so that a single 180° aperture is obtained without undue weakening of the wheel. The wheel contains 13 apertures, varying by two-thirds power of two ratio, which gives a range of expo-

sure from 1 to 256. Special means for balancing the sector wheel are employed. Exposures for one revolution are obtained by a mechanical shutter arrangement, which is semiautomatic in operation.

An ingenious mechanism has also been worked out for accurately controlling the speed of the motor which operates the machine. The motor is of the direct current, shunt wound type (a type not ordinarily used for such a purpose), and is controlled by a centrifugal governor. An arrangement of relays keeps the motor in step with a clock beating seconds.

The sensitometer is designed to cover an exposure range sufficiently wide to fit it for photographic research as well as routine testing.

A complete description of the machine will be published as one of the bureau's Scientific Papers.

A POSSIBLE COVERING FOR SOLARIUMS

An important present-day question is the covering of solariums for therapeutic treatments. The radiometry section of the bureau has received inquiries for a substitute for glass to transmit the short ultra-violet solar rays. Window glass of the thickness that would have to be used in order to provide mechanical strength and hence safety from breakage, with possible injury to the patient beneath such a covering, is opaque to the shortest ultra-violet rays of the sun. The same is true also of nitrocellulose when of a thickness of 0.5 to 1 mm. However, a thin (0.1 mm.) film of nitrocellulose on a wire mesh, such as is obtainable in commercial form (celoglass), even after it has assumed a light yellowish color, transmits proportionately more of the shortest ultra-violet solar rays than glass or celluloid in thick layers.

The samples under test, when exposed to the radiation from a quartz mercury lamp, turned brown in color; also separated from the wire mesh. The outstanding question is whether it is better to have the sunlight pass through the

plane glass window and fall directly upon the patient or to have diffuse sunlight, such as is obtained through the cellulose screen.

Until quartz glass can be produced cheaply it appears that the thin film of nitrocellulose on a wire mesh is the best substitute now available. As already stated, the cellulose turns brown on exposure to the sun, decreasing its transparency to the short ultra-violet rays. Hence, if this type of window is used it should be replaced when discolored.

USE OF BAUMÉ SCALE IN MOLASSES ANALYSIS

During the past few months the bureau has had a number of requests for information in regard to the use of the Baumé scale, particularly in connection with the sale of molasses and sirups. There exists considerable uncertainty in the use of Baumé to express density, probably because of the large number of different scales in use. It has recently been suggested that the scale of Bates and Bearce as described in Technologic Paper No. 115 be accepted in trade transactions. This scale is based on the best scientific data available. This would undoubtedly eliminate many of the misunderstandings and inaccuracies. It is the general practice to determine Baumé on molasses at temperatures between 100 and 140° F. To correct the Baumé reading for temperature it has been necessary to convert the reading to the equivalent in Brix, correct the Brix value for temperature, and then convert the corrected Brix back to the equivalent in Baumé. To eliminate this round-about method of correction, a table of temperature corrections for Baumé hydrometers has been calculated.

The bureau has undertaken to inform interested parties in regard to the whole question of Baumé determinations, with a view to having a standard scale adopted and also a standard method of making the determination. A series of determinations have been made for purposes of comparison with the results ob-

tained in the laboratories of a sugar company. Other collaborative tests will probably be carried out.

RADIO-FREQUENCY INDUCTANCE COILS

During the past year the bureau has carried on an investigation of the radio-frequency resistance and other properties of various types of coils suitable for use in radio receiving sets at broadcast frequencies. Typical coils were constructed at the bureau and were adjusted to have the same inductance at a low frequency (1 kilocycle). Measurements were made of the resistance and inductance at frequencies covering the broadcast band (500 to 1,500 kilocycles). The coils included several types made up of solid and litz wire, single and multiple-layer coils of several types of winding, single-layer coils of various sizes of wire, and single-layer coils covered with different kinds of insulating binder. The results obtained have been summarized by means of curves and a paper reporting these measurements has been prepared. Its publication will be announced in the bulletin.

In order to improve the sharpness of resonance of some of the bureau's standard frequency meters (wave meters), especially at frequencies above 1,000 kilocycles, a study is being made of the radio-frequency resistance of inductance coils used for this purpose. Coils have been made of various types of conductors, including solid copper wire, copper tubing, and litz wire of various sizes, and resistance measurements made at varying frequencies. It appears from the preliminary results that in the design of a standard frequency meter no single size or type of wire is suitable for all inductors, but that in order to obtain the best results different kinds of wire must be used on the coils for different frequency ranges.

LAMINATED PHENOLIC INSULATING MATERIALS

In measuring the radio-frequency properties of laminated phenolic insulating materials (bakelite, etc.), the results of

which have been published in Bureau of Standards Technologic Paper No. 216, Properties of Electrical Insulating Materials of the Laminated, Phenol-Methylene Type, some samples were found to exhibit changes in these properties with time. This led to the work described in a paper just issued, Technologic Paper No. 284, A Study of the Seasonal Variation of Radio-Frequency Phase Difference of Laminated Phenolic Insulating Materials, copies of which may be obtained from the Superintendent of Documents, at 5 cents each. This paper is based on a study made in 1920-21 of some representative samples to learn whether the variations of phase difference follow any definite trend with season. It was found that the phase difference or power factor varied with the season of year, reaching a maximum in late summer, and in most cases returned to its original value after undergoing a year's cyclic changes. The variations with season were, in general, no greater than variations from sample to sample.

PUBLICATIONS OF THE BUREAU OF STANDARDS RELEASED DURING JUNE

Scientific Papers

S500. A method of determining the dew points of fuel-air mixtures, Roy J. Kennedy. Price, 10 cents.

Technologic Papers

T278. Effect of twist on the physical properties of a number 7s yarn, F. R. McGowan, Charles W. Schoffstall, and A. A. Mercier. Price, 10 cents.

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United States Government Master Specifications for—

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C229. Friction tape. Price, 5 cents.

C230. Rubber insulating tape. Price, 5 cents.

Miscellaneous Papers

M56. Tables and graphs for facilitating the computation of spectral energy distribution by Planck's formula. Price, 35 cents.

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Simplified Practice Recommendations, Elimination of Waste

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